

Wire-line Analysis Tool for Subsurface Observations of Northern-ice-sheets: The WATSON Project

Completed Technology Project (2015 - 2018)



Project Introduction

The windows to the terrestrial historical climate record can be accessed through analysis of ice cores from polar ice sheets such as those found in Greenland. Surface processes such as desertification, volcanic activity, and meteoritic impacts can be observed in the dust particles trapped in ice layers. Similarly the polar ice caps on Mars offer a means to survey the climate and, through the analysis of organics and minerals preserved in the ice, the habitability of the planet. The overarching goals are to use an in-situ organic/mineral spectrometer integrated into a ice borehole drilling system to address two science questions associated to microbial and organic distribution and persistence in subsurface ice sheets as well as two science mission operations goals. To achieve these goals the proposed effort will include laboratory analysis in coordination with the National Ice Core Labs (NICL) and field deployments to the Fremont Glacier and Greenland to drilling new 100m boreholes for in-situ analysis. As part of this program a TRL 5 deep UV fluorescence/Raman imaging instrument that spatially maps the distribution of organics, microbes, minerals, and anions, on surfaces and in ice, will be integrated into an existing wire-line drilling system. This integration will require only minor modification that will occur in year 1. The integrated system will address the following science questions under this program: 1) What can the organic and microbial micro-scale spatial distributions within ice tell us about past climate and habitability? Do these features remain localized within the initial dust accumulation zone or migrate across zones through ice veins? This requires access to both currently available cores as well in-situ measurements to assess what effects are associated to contamination and/or a result of ice core volume relaxation (removal from hydrostatic pressures). 2) What is the effect of the radiation environment on the preservation potential of organic and microbial densities? Our analyses of subsurface ice formed in high altitude, high UV environments (Fremont Glacier — Wyoming) will be compared to data collected on Greenland ice (near GISP2). In addition to advancing the understanding of microbial and organic distributions in terrestrial ice sheets, these science investigations will lead to an understanding of the organic/microbial related features may be preserved in the subsurface ice of Mars polar caps and how they would be distributed in the presence of biogenic activity. In addition to the science investigations, the proposal will include science mission operations and will incorporate autonomy enable drilling and in-situ analysis. This is a necessary requirement for terrestrial ice analysis and for planetary ice analysis where rapid analysis is required to avoid potential closing of ice borehole. The autonomy leverages both prior drilling programs as well as deep UV instrument development under NSF, NASA, and DoD. The operations will demonstrate 1) achieving the science goals in-situ, without the complexity of sample handling and sample processing of core extraction or manipulation and 2) acquisition of multiple ice boreholes will be used to demonstrate the effect of site selection and variability in science return. These results will be used to better understand the formulation of a future Mars polar mission that accesses the subsurface



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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Responsible Program:

Planetary Science and Technology Through Analog Research

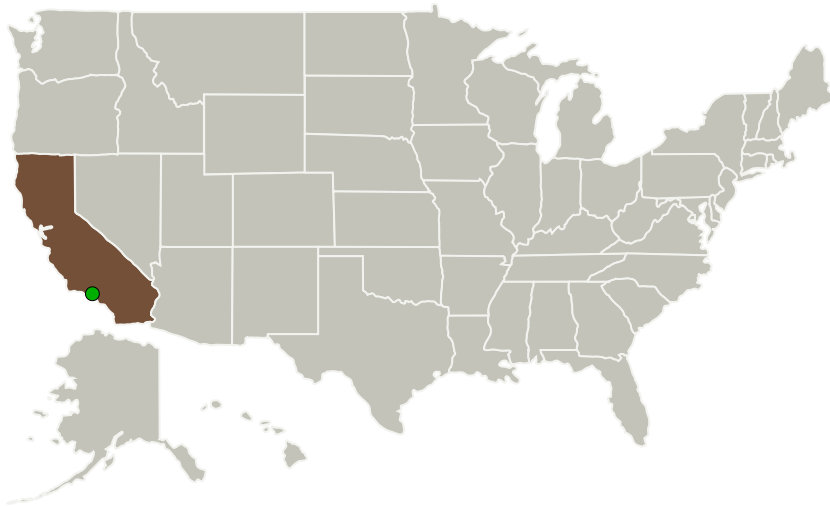
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Primary U.S. Work Locations and Key Partners



| Organizations Performing Work | Role | Type | Location |
|----------------------------------|-------------------------|-------------|----------------------|
| ● Jet Propulsion Laboratory(JPL) | Supporting Organization | NASA Center | Pasadena, California |

Primary U.S. Work Locations

California

Project Management

Program Director:

Carolyn R Mercer

Program Manager:

Sarah K Noble

Principal Investigator:

Rohit Bhartia

Co-Investigator:

Karen R Piggee

Technology Areas

Primary:

- TX01 Propulsion Systems
 - └ TX01.3 Aero Propulsion
 - └ TX01.3.11 Engine Icing

Target Destination

Others Inside the Solar System